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December 9, 1993

WavePhore, Inc.  
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FEDERAL COMMUNICATIONS COMMISSION  
OFFICE OF THE SECRETARY

Mr. Roy J. Stewart  
Chief, Mass Media Bureau  
Federal Communications Commission  
1919 M Street, NW  
Room 314  
Washington, D.C. 20554

Dear Roy:

We are writing to you seeking clarification that television broadcasters licensed by the Commission may use WavePhore's TVT1 technology without seeking prior approval from the Commission. TVT1 is a new technology that is consistent with present NTSC standards and Commission rules; it allows television stations to transmit high-speed data within the bandwidth of their present signals without visible degradation to the video signal or interference to other stations. The public will benefit from TVT1 as an efficient way to bring high-speed data to tens of millions of households without the allocation of additional spectrum. Broadcasters will benefit from the ancillary business opportunity of using their existing facilities to broadcast high-speed data.

WavePhore, Inc. is a technology research company and has been operating since 1990. It has over thirty scientists and engineers working on advanced communications technologies and has invested over \$10 million in developing technologies for the transmission and compression of digital audio and video. It was WavePhore's development of its data broadcasting technology that encouraged the NAB and EIA to establish a Data Broadcast Standards Committee.

The technology developed by WavePhore is called the TVT1 system. The system consists of an encoder at the television transmitter, injecting a high-speed data stream into the video signal, and decoders that may be located virtually anywhere that a good quality over-the-air video signal is available from the transmitter. WavePhore is working to shrink the decoder down to approximately the size of a cigarette pack. The system currently relays data at 384 Kbps, which is 40 times the speed of a standard telephone modem. Wavephore anticipates that it will be able to inject data at 1.544 Mbps in the near future using the same basic technology. Anticipated uses include: distribution of educational and instructional materials, health care information, electronic newspapers, financial services information, software, and fare and schedule information.

While the exact services and operational structure of individual TVT1 systems will be determined by the market, WavePhore envisions broadcasters as the operators of TVT1 equipment, utilizing the vast amount of data the broadcasters have at their disposal, as well as third party data services as the source of data relayed over the systems. The decoder equipment, which WavePhore anticipates costing about \$100 per unit, would be owned by consumers of the service and could be either an add-on unit or included in the circuitry of television sets.

The TVT1 product, for which a patent application is pending and a notice of allowance has been issued, transmits digital data within an NTSC television signal. The data does not cause any interference to other stations because it generates no out of band spectral components. The data is added to baseband video so that no out-of-band spurious signals are generated and there is no impact on any transmission in the vertical blanking interval.

The TVT1 system takes advantage of a narrow band within the NTSC signal, between 3.9 MHz and 4.2 MHz within the standard 6 MHz channel. The data power level is kept very low so as not to cause any artifact visible on a TV set. The data is inserted as a low amplitude signal over a narrow 300 kHz band between the video and the audio portions of the NTSC signal. The encoder performs two functions: a slight lowpass filtering and delay equalization of the video signal and a linear addition of the data to the video. The video lowpass filter has practically no impact on the actual video signal since it is on the side of the vestigial sideband. The delay equalizer corrects for any phase distortion and ensures sharp color transitions. The data power level is such that it is barely above the video noise floor. All

of this is consistent with Commission rules and regulations for television broadcasting.

The injection of data causes no visual degradation of the television picture as viewed on any commercial TV set. The absence of any visible degradation is the result of:

The design of commercial television tuners. All commercial TV tuners roll off the part of the spectrum that contains the data. As a result, commercial televisions are not even capable of receiving transmissions in this portion of the spectrum. In fact, WavePhore had to design a special tuner for its decoder unit because there are no commercially-available tuners capable of receiving signals in the portion of the band that Wavephore's equipment uses.

The low power level at which the data is injected. The amplitude of the data is only a few IRE above the video noise floor and therefore is almost impossible for anyone including a trained professional to discern. Even with a sensitive spectrum analyzer, the data would be seen as only a small narrowband bump.

The narrow band (300 kHz) at which it is injected. The data spectrum utilized is a narrow 300 kHz band which adds no significant component to the video noise when integrated and weighted over a 4 MHz bandwidth.

Interleaving with the chroma and lumina. The data sub-carrier is around 4.2 MHz. The exact frequency and phase of the carrier are such that the resulting 'picket fence' data spectrum is interleaved with respect to the comb structure of the chroma and lumina spectrum, thus preventing perceptible degradation.

WavePhore has conducted hundreds of hours of tests pursuant to experimental authority from the Commission on two television stations in the Phoenix area. As attested to by the attached statements from the stations themselves, the TVT1 technology does not cause any degradation to any commercial television sets. During the entire time the tests were being conducted, including the earliest stages of testing and during daytime testing, the stations have received no complaints from their viewers.

In addition, we recently invited the consulting engineering firm of Cohen, Dippell and Everist to conduct critical viewing tests of the WavePhore technology. The critical viewing tests were done on a variety of types of commercial television receivers at several sites in the Phoenix area. The attached

report concludes that "there was no perceptible degradation of visual or aural signals on any receiver at any site."

The benefits of this technology are substantial. Even operating at its current rate of 384 Kbps, the TVT1 system transmits data at 40 times the rate of most commercial modems. In addition, unlike modems, which operate on a point-to-point basis, the TVT1 system can relay data to an unlimited number of receivers simultaneously. No telephone lines or dedicated wiring is required to receive this data, thus greatly increasing its usefulness and availability while reducing its cost.

The utility of the TVT1 technology to the establishment of the "data superhighway" is obvious. Initiation of widely available high-speed data transmission could begin almost immediately at very low cost and without the construction delays that a wired system would entail. Even better, this can be accomplished without allocation of any spectrum, thus preserving a scarce national resource through better spectral efficiency.

Use of the TVT1 system will provide television broadcasters with a new revenue stream. Given the competitive pressures faced by these broadcasters as well as the important local public service they offer, such a revenue stream could be invaluable for ensuring continued or enhanced public service broadcasting. Since the TVT1 signal can be "piggybacked" on the video signal without harming the picture or causing any other interference, the television broadcasters with which we have discussed the TVT1 system have been enthusiastic about its possibilities both as a technology and as a source of revenue enhancement.

There is ample basis for the requested ruling. As noted above, the technology is consistent with present NTSC technology and the Commission's own rules. No allocation of spectrum is required; and the Commission has previously found such ancillary uses of the broadcast spectrum to be in the public interest. The Commission has allowed both radio and television broadcasters to make whatever subsidiary use of their channels they desire so long as the use does not constitute a "special signal," i.e., a signal which causes discernable picture degradation or interference to other broadcast stations.<sup>1/</sup> Where these criteria are met, no prior individual FCC authorizations are required. Examples of such technologies include use of AM and FM subcarriers and the vertical blanking interval of television

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<sup>1/</sup> See Uses of Special Signals for Network Purposes Which Adversely Affect Broadcast Service, 22 FCC2d 779 (1970).

transmissions, which have been used for utility loading, teletext, closed captioning, and paging operations.<sup>2/</sup>

In the area of television broadcasting specifically, the Commission has previously allowed stations to transmit data in the vertical blanking interval,<sup>3/</sup> broadcast 3-D programming requiring viewer glasses,<sup>4/</sup> and transmit low speed data in the active video signal.<sup>5/</sup>

With regard to teletext, the Commission found that since teletext had numerous public interest benefits, so long as use of the vertical blanking interval to transmit information did not degrade picture quality, broadcasters could utilize it without prior Commission authorization.<sup>6/</sup> In a separate decision, the Commission found that use of the vertical blanking interval for non-teletext data services such as paging and data delivery was also in the public interest and therefore should be given the same leeway as teletext.<sup>7/</sup>

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- 2/ See Amendments of Part 2 and 73 of the Commission's Rules Concerning Use of Subsidiary Communications Authorizations, 53 RR2d 1519 (1983); Amendment of Parts 2, 73 and 76 of the Commission's Rules to Authorize the Transmission of Teletext by TV Stations, 57 RR2d 842 (1985); Amendment of Parts 2, 73 and 76 of the Commission's Rules to Authorize the Offering of Data Transmission Services on the Vertical Blanking Interval by TV Stations, 57 RR2d 832 (1985).
- 3/ See Amendment of Parts 2, 73 and 76 of the Commission's Rules to Authorize the Offering of Data Transmission Services on the Vertical Blanking Interval by TV Stations, 57 RR2d 832 (1985).
- 4/ See Transmission of Three-Dimensional (3-D) Programming by Television Broadcast Stations, 51 RR2d 661 (1982).
- 5/ See March 3, 1992 letter from Roy J. Stewart to Jane E. Genster of NBC (attached).
- 6/ Amendment of Parts 2, 73 and 76 of the Commission's Rules to Authorize the Transmission of Teletext by TV Stations, 53 RR2d 1309 (1983).
- 7/ Amendment of Parts 2, 73 and 76 of the Commission's Rules to Authorize the Offering of Data Transmission Services on the Vertical Blanking Interval by TV Stations, 57 RR2d 832 (1985).

In the decision that may be most relevant to the TVT1 proposal, the Commission approved NBC's use of a system which, like the Wavephore proposal, transmits data in the active video signal.<sup>8</sup> Although the specific process utilized by NBC is different than that of WavePhore, the basic concept--a data stream embedded in the video portion of the television channel--is identical. The most significant difference between the two technologies is that NBC's system transmitted only 240 bits per second, while the TVT1 system currently transmits data at 384 thousand bits per second. As a result, the utility and public interest benefits of the WavePhore system are much greater than the NBC system.

In declaring that NBC needed no prior Commission authorization for its system, the Commission's staff, acting under delegated authority, stated that "[b]ecause we find that the SDTS signal does not degrade the broadcast signal in any discernible way, no such authorization is needed."<sup>9</sup> The Commission's staff went on to state that "[w]e also conclude, based on current evidence, that the possibility that one station could interfere with another is not altered by the inclusion of the SDTS signal in either station's signal. However, should such interference occur, or should degradation of the visual or aural signal develop at some time in the future, we expect NBC to immediately inform the Commission of the circumstances, and to take steps to resolve the situation, if necessary by discontinuing transmission of the SDTS signal."<sup>10</sup>

WavePhore believes that it falls squarely within the bounds of the NBC decision, as its system "does not degrade the broadcast signal in any discernible way," and creates no increased risk of interference to other stations. WavePhore believes that it has provided ample evidence that its technology will not cause visible degradation to television broadcast signals. Nonetheless, it accepts that any use of its technology by broadcast licensees would be conditioned, implicitly or otherwise, on this absence of degradation.

In sum, WavePhore is proposing a new technology that can deliver data at high speeds over a large area, requires no

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8/ See March 3, 1992 letter from Roy J. Stewart to Jane E. Genster of NBC (attached).

9/ Id. at 2.

10/ Id.

Mr. Roy J. Stewart  
December 9, 1993  
Page 7

additional spectrum, will benefit television broadcasters and the public, and can do so at very low cost. If allowed to go forward with the TVT1 system without expending undue time hurdling regulatory obstacles, WavePhore and television broadcasters can rapidly establish a solid foundation for the information superhighway while achieving greater spectral efficiency. WavePhore therefore respectfully requests that the Commission clarify that no prior authorization is needed from the Commission and that broadcasters may immediately begin utilizing the TVT1 system on their current channels.

Respectfully submitted,



David E. Deeds  
Chairman, CEO and President

Counsel:

Bruce D. Jacobs  
Scott R. Flick  
Fisher, Wayland, Cooper & Leader  
1255 23rd Street, NW  
Suite 800  
Washington, DC 20037  
(202) 659-3494

# **KUTP-TV PHOENIX**

TOM FOY  
Chief Engineer

December 6, 1993

## DECLARATION

I, Hugh Thomas Foy, under penalty of perjury, do hereby declare as follows:

1. I am the Chief Engineer of KUTP(TV), Phoenix, Arizona, and have been its Chief Engineer for the last eight years. I have been employed in the broadcast industry for 22 years.
2. Wavephore, Inc. conducted tests on KUTP(TV) during September and October 1993. For a two month period, Wavephore utilized its TVT1 equipment to transmit data over KUTP(TV) on an almost continuous basis between the hours of 8 a.m. and 5 p.m. The testing caused no interference to KUTP(TV)'s signal nor to the signal of any other local station.
3. During the testing, I had the opportunity to view the KUTP(TV) signal on numerous consumer television sets around the Phoenix area. On none of these sets was I able to see any degradation of the video signal as a result of the operation of the Wavephore equipment. During the entire testing period KUTP(TV) received no viewer complaints of any kind concerning the station's signal quality.

  
Hugh Thomas Foy



WILLIAM H. LAWRENCE  
CHIEF ENGINEER

### DECLARATION

I, William H. Lawrence, under penalty of perjury, do hereby declare as follows:

1. I am the Chief Engineer of KTVK(TV), Phoenix, Arizona, and have been its Chief Engineer for the last eleven years. I have been employed as a broadcast engineer for 35 years.
2. WavePhore, Inc. has been conducting tests on KTVK(TV) since July of 1993. During this time, WavePhore has utilized its TVT1 equipment to transmit data over KTVK (TV) on an almost continuous basis between the hours of 8 a.m. and 5 p.m. The testing caused no interference to KTVK(TV)'s signal, nor to the signal of any other local station. No viewer complaints relating to the operation of the TVT1 system were received during the testing period.
3. During the course of the testing, I became quite familiar with the TVT1 system and was very impressed not only with its technical performance, but with the tremendous possibilities for broadcasters that the technology holds. The system reliably relayed large quantities of data with exceptional accuracy and required minimal installation effort.
4. While the TVT1 system was being used to relay data over KTVK(TV)'s signal, I observed KTVK(TV)'s signal on several different television sets in the area and was unable to detect any video noise being caused by the TVT1 system. Even on a wideband studio monitor, I was only able to discern video artifacts of the TVT1 signal by turning the data stream on and off. On the commercial television receivers I observed, I was not able to discern any video noise even with this technique. I did notice one minor problem in that the TVT1 system's signal filter was inducing a slight delay in the chroma signal which, while not discernible in virtually all programming, could be detected in a close examination of a test pattern. I have discussed the matter with WavePhore's engineers and they have indicated that they are improving the signal filter of the TVT1 system to reduce this chroma delay. My understanding is that such an improvement can be accomplished fairly easily.

  
William H. Lawrence

Date: 12-6-93

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OFFICE OF THE SECRETARY

**ENGINEERING REPORT  
ON BEHALF OF  
WAVEPHORE, INC.  
RE CRITICAL VIEWING AND LISTENING TESTS OF  
NORMAL TELEVISION PROGRAMMING WITH  
SIMULTANEOUS INSERTION OF A  
384 KBS PACKETIZED DATA STREAM  
NOVEMBER 1993**

**COHEN, DIPPELL AND EVERIST, P.C.  
CONSULTING ENGINEERS  
RADIO AND TELEVISION  
WASHINGTON, D.C.**

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WASHINGTON, D.C.**

COHEN, DIPPELL AND EVERIST, P. C.

City of Washington

)

) ss

District of Columbia

)

Warren M. Powis, being duly sworn upon his oath, deposes and states that:

He is a graduate electrical engineer of the University of Canterbury, New Zealand, a Registered Professional Engineer in the District of Columbia, the State of Virginia, the State of South Carolina, and Vice President of Cohen, Dippell and Everist, P.C., Consulting Engineers, Radio - Television, with offices at 1300 L Street, N.W., Suite 1100, Washington, D.C. 20005; previously employed for 15 years with the New Zealand Broadcasting Corporation; a member of the Institution of Professional Engineers New Zealand (IPENZ), the Association of Federal Communications Consulting Engineers (AFCCE), and the National Society of Professional Engineers (NSPE).

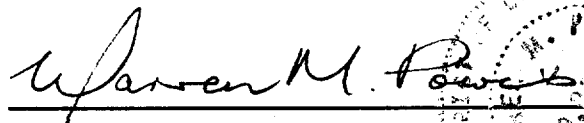
That his qualifications are a matter of record in the Federal Communications Commission;

That he has undertaken critical subjective viewing tests of television signals in New Zealand and the United States;

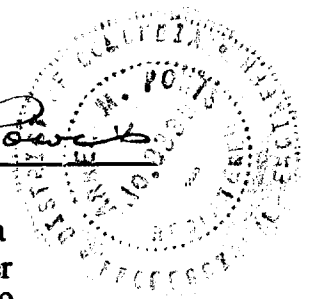
That he participated as an expert observer during recent testing of advanced television transmission systems at the Advanced Television Test Center, Inc. at Alexandria, Virginia.

That the attached engineering report was prepared by him or under his supervision and direction and,

That the facts stated herein are true of his own knowledge, except such facts as are stated to be on information and belief, and as to such facts he believes them to be true.



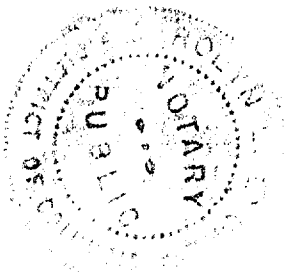
Warren M. Powis  
District of Columbia  
Professional Engineer  
Registration No. 8339



Subscribed and sworn to before me this 26<sup>th</sup> day of November, 1993.

  
Notary Public

My Commission Expires: 2/28/98



### Introduction

This engineering report has been prepared on behalf of Wavephore, Inc. ("Wavephore") to report on the observations of the Wavephore TVT1™ system of digital data signals located within the visual pass-band of television station transmissions. Observations of both off-air and studio output signals were made on various television receivers to search for perceptible artifacts, increased visual noise and audio artifacts.

Observations were made on November 11 and 12, 1993 during normal off-air program signals transmitted throughout the broadcast day from the United Television, Inc., UHF television station KUTP-TV, Channel 45, Phoenix, Arizona. KUTP-TV operates non-directionally with an effective radiated power of 2750 kW (34.4 dBk) with an antenna height above average terrain (AHAAT) of 545 meters from South Mountain, located approximately 13 km south of Phoenix.

Absolute and wide-ranging system tests and measurements were not performed and are beyond the scope of this report. Critical viewing tests of the television signals were performed on normal programming material whilst switching the data stream source<sup>1</sup> in and out of service. The switching was done at the studio upon request via telephone from each observation site. Several different types, models and sizes of television receivers were used. Observations were made at the following five locations:

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<sup>1</sup>The low level data stream is transmitted only in the video passband on lines used for transmission of picture information.

- Wavephore, 2601 West Broadway Road, Tempe, AZ
- KUTP-TV studios, 4630 South 33rd Street, Phoenix, AZ
- Jerry's Audio-Video Store, 600 E. Camelback Road, Phoenix, AZ
- Tomahawk Road, near Apache Junction
- Desert Cove and Tatum

Critical viewing tests of the received television signal were made with the data stream being switched on and off; either on request or on a 10-second cycle of 5 seconds on/5 seconds off. Baseband demodulated video at the Tomahawk and Desert Cove locations were recorded on a Sony Model CCD-V110 8 mm camcorder, serial number 220574 to search for potential artifacts in the playback mode. In addition, photographs of received images were taken with a Pentax K1000 35 mm camera.

### **VIEWING TEST SITES AND METHODOLOGY**

#### **Fixed Site Observations**

##### **Wavephore**

The monitoring system at the Wavephore site used for the viewing test consisted of a 4-bay "bow-tie" receive antenna with rear reflector mounted approximately 15 feet above ground level. The output of the antenna was fed by a 75 ohm coaxial line to a passive splitter with two outputs; one output feeding a Sony Trinitron color television receiver (model KV-13TR20, serial number 8104963), and the other output of the passive splitter feeding test equipment.

### **KUTP-TV Studio**

Comparative monitoring of the video signal was made as follows:

- Monitor A<sup>2</sup> used to view video prior to addition of Wavephore data
- Monitor B used to monitor the KUTP-TV transmitter output (return to studio via microwave link)

The comparative monitoring revealed no perceptible change to the video signal between the monitors.

### **Jerry's Audio-Video Store**

Critical listening and viewing tests were made on the following receivers:

- Mitsubishi Model VS-7071 70-inch projection receiver
- Model Model CS-40601 40-inch cathode ray tube receiver

Audio monitoring was undertaken on these receivers as well as on various Sony receivers for potential degradation of audio quality of KUTP-TV for monophonic, stereophonic and sap audio programming.

## **MEASUREMENT VAN OBSERVATIONS**

### **Tomahawk Road, Apache-Junction** (non-obstructed site)

Measurement van observations were made at two sites identified by Wavephore--the Tomahawk site is unobstructed while the Desert Cove site is obstructed from direct signals.

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<sup>2</sup>Monitors A and B were both Ikegami monitors, type number PM20-9RHA. Observations were made with the monitors in the color and in the monochrome positions.

A recreational vehicle fitted with test equipment including a Tektronics model 1450-1 television demodulator with tunable down converter, Model TDC2, was used to feed a Sony Trinitron Model KV1393R television receiver.

The Tomahawk Road site is located approximately 32 miles east of the KUTP(TV) transmitting site.

**Desert Cove & Tatum** (obstructed site)

The recreational vehicle was driven to this site located approximately 30 miles north of KUTP-TV transmitting site. The direct signal is blocked by intervening mountains. In addition, approximately one-third of a mile towards KUTP-TV, high-voltage power lines produced perceptible noise bars on the received picture.

**VISUAL AND AURAL OBSERVATIONS**

There was no perceptible degradation of visual or aural signals on any receiver at any site to the off-air reception of KUTP-TV. Careful search of the received pictures was made, while the data was switched, for artifacts and various effects including:

- noise patterns
- noise increase
- color change
- ghost/echo
- areas of sudden color change
- aural noise and distortion



There was no perceivable degradation of the recorded video on the 8 mm camcorder in the playback mode on the following receivers:

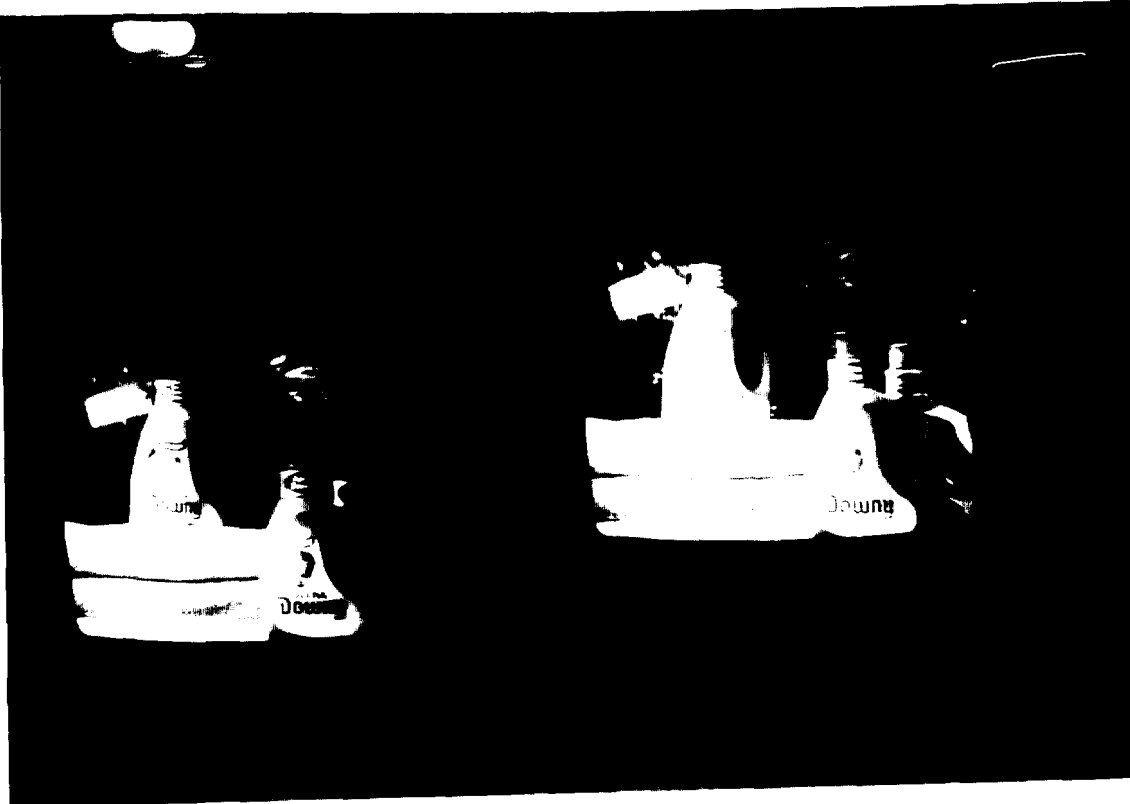
Sony, Model KV-13TR20, Serial No. 8104963

Magnavox, Model RX4241, Serial No. 82254265

No perceivable degradation or artifacts on the transmitted picture were found in the photographs taken using the 35 mm camera. In addition, based on discussions with the KUTP director of engineering, no viewer complaints were received by KUTP-TV during the entire time that the technology has been tested.

There were no observed degradation to visual or aural reception on any television receiver at any location.

A



B

A



B

KUTP-TV STUDIO PICTURES  
 A: STUDIO VIDEO PRIOR TO  
 ADDITION OF DATA SIGNAL  
 B: TRANSMITTER OUTPUT WITH DATA  
 RETURNED VIA MICROWAVE  
 NOVEMBER 1967

COHEN, DIPPELL and EVERIST, P.O. Box 1000, Engineering Engineers Washington, DC



DATA  
OFF



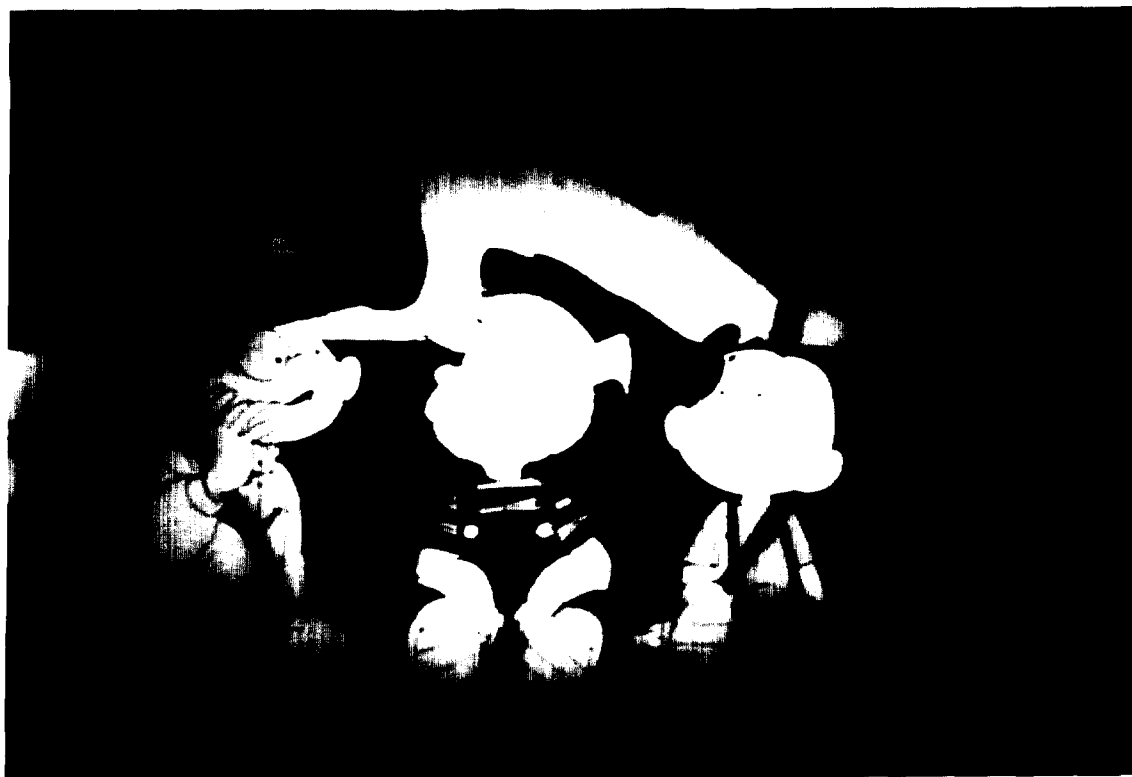
DATA  
ON

OFF-AIR KUTP-TV SIGNALS  
WITHOUT AND WITH DATA  
SITE: WAVEPHORE  
RECEIVER: SONY TRINITRON  
NOVEMBER 1993

COHEN, DIPPELL and EVERIST, P.C. Consulting Engineers Washington, DC



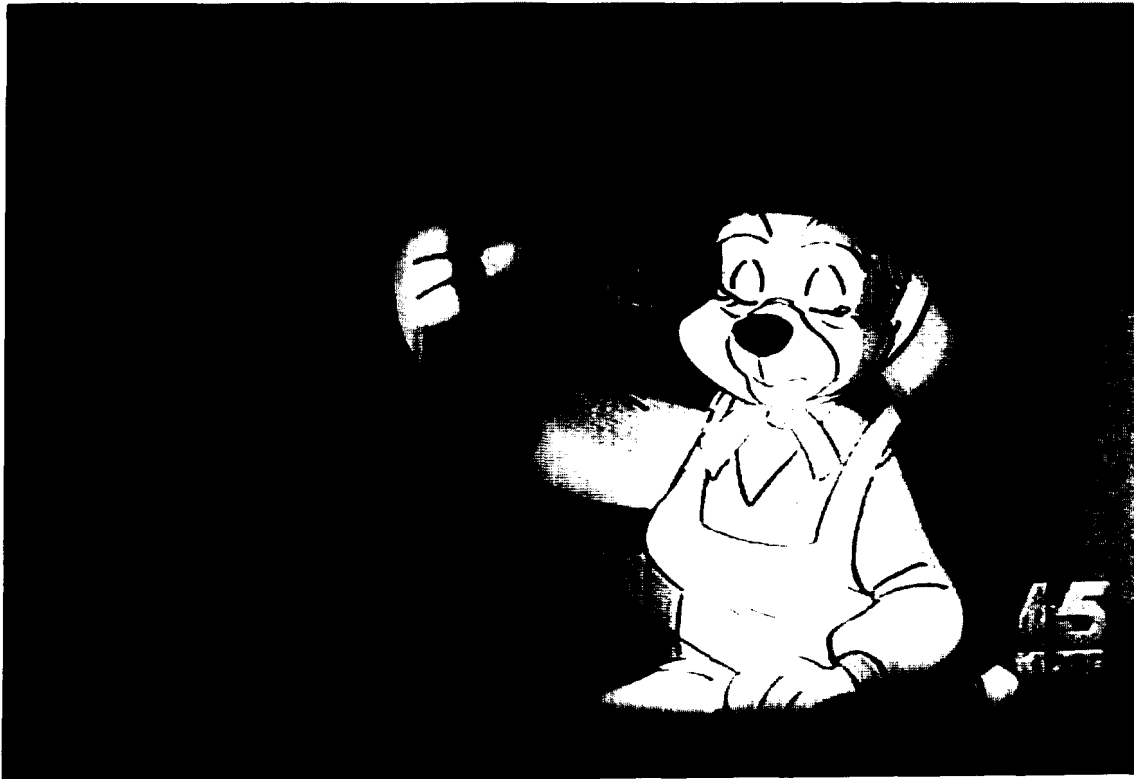
DATA  
OFF



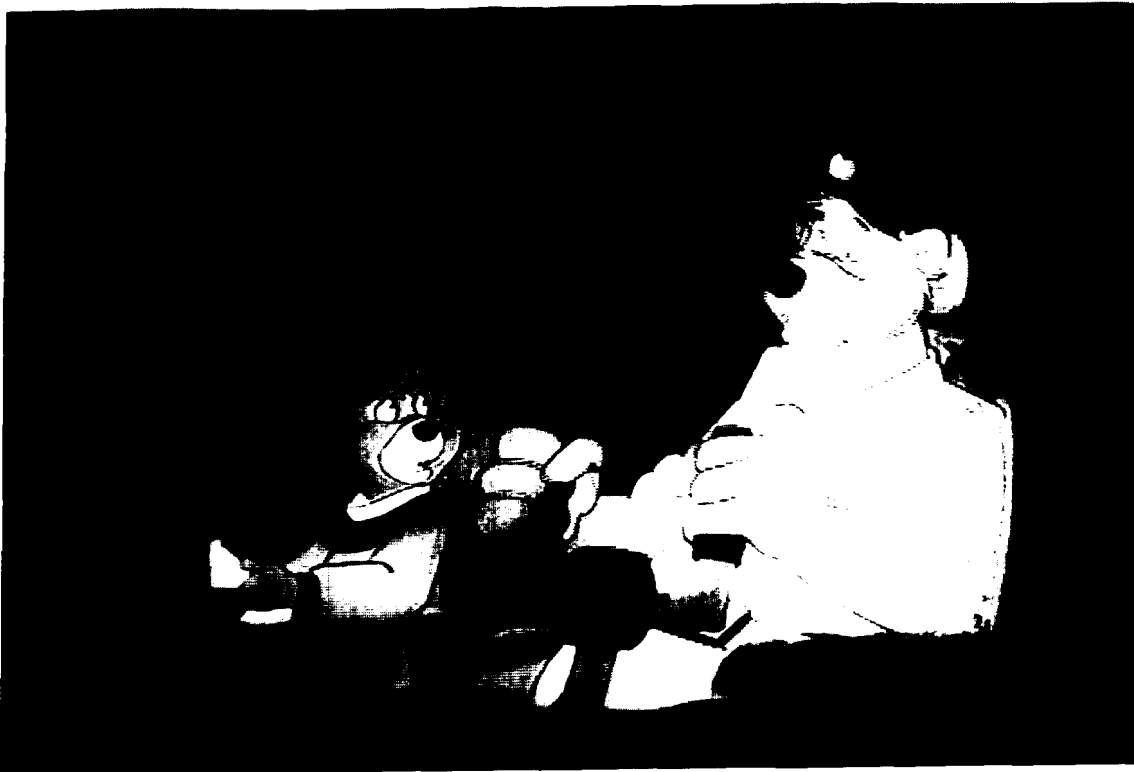
DATA  
ON

OFF-AIR KUTP-TV SIGNALS  
WITHOUT AND WITH DATA  
SITE: GERRY'S AUDIO VIDEO  
RECEIVER: MITSUBISHI 70" PROJECTION  
NOVEMBER 1993

COHEN, DIPPELL and EVERIST, P.C. Consulting Engineers Washington, DC



DATA  
OFF



DATA  
ON

OFF-AIR KUTP-TV SIGNALS  
WITHOUT AND WITH DATA  
SITE: GERRY'S AUDIO VIDEO  
RECEIVER: MITSUBISHI 40 INCH  
NOVEMBER 1993

COHEN, DIPPELL and EVERIST, P.C. Consulting Engineers Washington, DC



DATA  
OFF



DATA  
ON

OFF-AIR KUTP-TV SIGNALS  
SITE: TOMAHAWK  
RECEIVER: SONY TRINITRON  
RF INPUT LEVEL: -14.5 dBu ACROSS 75 OHMS  
NOVEMBER 1993

COHEN, DIPPELL and EVERIST, P.C. Consulting Engineers Washington, DC



DATA  
OFF



DATA  
ON

OFF-AIR KUTP-TV SIGNALS  
SITE: DESERT COVE  
RECEIVER: SONY TRINITRON  
RF INPUT LEVEL: -38.3 dBu ACROSS 75 OHMS  
NOVEMBER 1993

COHEN, DIPPELL and EVERIST, P.C. Consulting Engineers Washington, DC